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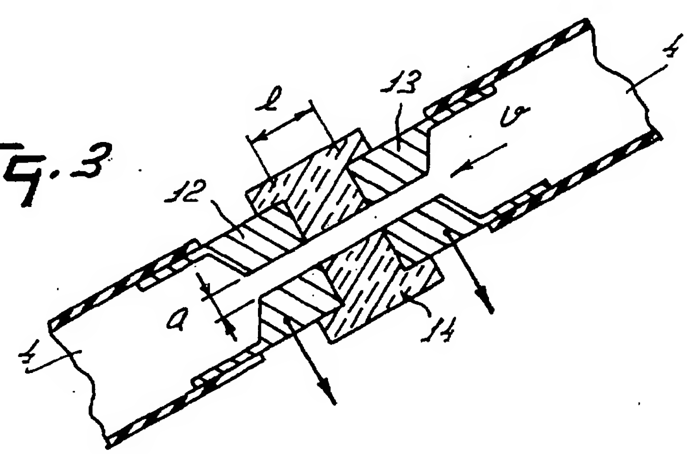
(54) **A Quantity meter and an implement for milking animals comprising such a meter**

(57) The invention relates to a quantity meter for determining the quantity of liquid flowing through a line, said quantity meter comprising two electrically conductive elements, provided in the line at a fixed measuring distance from each other, which are connected to an electronic circuit, whereby the diameter of the line, at least across the measuring distance, is such that during flowing through of the liquid the volume of the line across the measuring distance is completely filled for some time, and whereby furthermore in the electronic circuit the quantity (V) of liquid flowed through is determined on the basis of the electric conductivity (G(t)) of the liquid measured therein, dimensioning parameters of the quantity meter and the rate of flow (v) of the liquid. Each of the electrically conductive elements is constituted by a tube-like element, which tube-like elements are both kept at a fixed mutual distance (1) from each other by means of a further tube-like element made of an electrically non-conductive material and having an internal diameter which equals that of the adjacent parts of the two electrically conductive tube-like elements.

FIG. 3



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Description

[0001] The present invention relates to a quantity meter as described in the preamble of claim 1.

[0002] Such a quantity meter is known.

[0003] It is an object of the invention to improve the above-described quantity meter.

[0004] According to the invention this is achieved by the features as defined in claim 1.

[0005] According to the invention, there can be obtained a simple and reliable quantity meter when the latter comprises two electrically conductive elements, provided in the line at a fixed measuring distance from each other, which are connected to an electronic circuit, whereby the diameter of the line, at least across the measuring distance, is such that during flowing through of the liquid the volume of the line across the measuring distance is completely filled for some time, and whereby furthermore in the electronic circuit the quantity (V) of liquid flowed through is determined on the basis of the electric conductivity (G(t)) of the liquid measured therein, dimensioning parameters of the quantity meter and the rate of flow (v) of the liquid. In particular, the electronic circuit may comprise a microprocessor, in which the length of the interval of time (Δt), during which a quantity of liquid to be measured has flowed through the line, is at least approximately determined on the basis of the electric conductivity (G(t)), and in which the quantity (V) of liquid flowed through is at least approximately determined by the relation $V = a^*v^*\Delta t$, whereby (a) represents the size of the surface of the cross-section of the line between the electrically conductive elements, and the value of the rate of flow (v) is ascertained by means of calibration. In the microprocessor there can be determined more in detail the absolute conductivity (G_{abs}), ascertained in the time when the space in the line between the measuring points is completely filled with liquid, as well as a threshold value (α^*G_{abs}) depending thereon, whereafter the size of the surface defined by the function (G(t)) defining the electric conductivity is calculated, insofar as the function values exceed the threshold value (α^*G_{abs}), whereby the difference ($G_{abs} - \alpha^*G_{abs}$) between the absolute conductivity (G_{abs}) and the threshold value (α^*G_{abs}) is standardized at a constant value, e.g. "1", said surface defining the value of the interval of time (Δt). In order to obtain a rate of flow (v) as constant as possible of the liquid by means of the quantity meter, the latter is connected to a buffer reservoir, while there is provided a circulation line which, at one end, is connected to said buffer reservoir at the upper side thereof or near thereto and, at the other end, debouches into the discharge line of the quantity meter. In the microprocessor the rate of flow of the liquid can be determined by adjusting a constant value obtained by means of calibration by a factor depending on the quantity of liquid to flow through, which quantity of liquid is present in the buffer reservoir, and the angle through which the quantity meter is connected to the buffer reservoir, which factor is obtained, by means of calibration, for a number of quantity values in the buffer reservoir and for a determined angle value.

[0006] For determining the absolute conductivity (G_{abs}) it is desirable that the diameter of the line, at least across the measuring distance, is such that during flowing through of the liquid the volume of the line at least across the measuring distance is completely filled for some time. In view thereof and certainly when small quantities of liquid flow consecutively pulsationwise through the line, it is advantageous when the line comprises a narrowing and the electrically conductive elements are disposed in this narrowing. When the liquid flows pulsationwise through the line, there can be determined in the microprocessor of each of these pulsations the quantity (V) and on the basis thereof, by summation, the total quantity (V_{tot}).

[0007] According to a further aspect of the invention, the quantity meter as described in the foregoing can be applied in an implement for milking animals, such as cows. In that case not only the electric conductivity of the milk of the various animals will differ, but the electric conductivity of the milk of one and the same animal may also be different at consecutive milking runs, e.g. because a latent mastitis has occurred. Even during milking an animal, said electric conductivity may change somewhat in value, which occurs e.g. with foremilk, which has in general an electric conductivity deviating from the milk flow to be obtained later. Moreover, during milking, the milk flow is obtained pulsationwise, more in particular depending on the pulsation frequency at which milking takes place. By using the above-described quantity meter, it will be possible to take all these particular circumstances into account.

[0008] In accordance with the invention, the implement for milking animals will be provided with teat cups capable of being connected to the teats of the animals to be milked and a milk tank for collecting the milk obtained via the teat cups, whereby in a line between one or more teat cups and the milk tank there is included a buffer reservoir to which there is connected a quantity meter of the above-described type, while there is furthermore provided a circulation line which, at one end, is connected to said buffer reservoir at the upper side thereof or near thereto and, at the other end, debouches into the discharge line of the quantity meter. By disposing between each teat cup and the milk tank such a buffer reservoir with the quantity meter connected thereto, it will be possible to determine the quantity of milk obtained from the separate udder quarters of the animal.

[0009] The application of a quantity meter of the above-described type in an implement for milking animals is particularly important when said implement comprises a milking robot for automatically cleaning the teats, automatically connecting the teat cups to these teats, automatically milking the animal and automatically disconnecting the teat cups from the teats.

[0010] For a better understanding of the invention and

to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows schematically an implement for milking animals, provided with a quantity meter in accordance with the invention;
Figure 2 shows an embodiment of the quantity meter according to the invention;
Figure 3 shows a detail of said quantity meter, and
Figure 4 shows a diagram with the aid of which the function of the quantity meter is explained.

[0011] In Figure 1 there is represented a milking installation 1 for an implement for automatically milking an animal, while, for the sake of simplicity, there is indicated only one teat cup 2. Furthermore, there is provided a buffer vessel constituted by a milk glass 3. The milk yielded per udder quarter by means of the teat cups 2 is supplied to the milk glass 3 via a separate milk line 4. From the milk glass 3 the milk is supplied, by means of a pump 5, via a milk discharge line 6, to a milk tank 7. Moreover, the milking installation comprises, insofar as is important for the present invention, a pulsation system 8 for the four teat cups 2. The vacuum line 9 for the pulsation system 8 is connected to a vacuum pump including a balance tank.

[0012] The quantity meter 10 according to the invention is included in the milk line 4. In this case the quantity meter comprises a passage element 11, composed of two electrically conductive elements 12 and 13, each constituted by a tube-like element, which are kept at a fixed mutual distance 1 from each other by means of a further tube-like element 14 made of an electrically non-conductive material and having an internal diameter which equals that of the adjacent parts of the two electrically conductive tube-like elements 12 and 13. Said diameter has a cross-sectional surface a, so that the volume in the passage element 11 between the two electrically conductive elements 12 and 13 has the value a*l. Said volume has to be such that, when a liquid is flowing through, the volume of the line across the measuring distance is completely filled for some time. The electrically conductive elements 12 and 13 are connected to an electronic circuit 15, in which the electric conductivity (G(t)) of the liquid flowing through the passage element 11 is determined. For measuring the quantity it is important that at least for some time the electric conductivity of a defined volume is determined. This value for the electric conductivity is indicated by G_{abs}. When the quantity of liquid flowing through the passage element 11 is too small or flows through pulsationwise, it may be necessary to keep the volume a*l relatively small. As shown in Figure 3, in the embodiment represented therein there is provided in the passage element 11 a narrowing keeping the volume a*l small.

[0013] Besides the passage element 11 there is included a buffer reservoir 16 in the milk line 4. Said buffer reservoir is provided in order to ensure that the milk flow passing through the passage element 11 is as stationary as possible, which is important when the liquid is supplied irregularly or pulsationwise. For that reason, in the present embodiment, the buffer reservoir 16 is funnel-shaped and the liquid is supplied at the upper side thereof in such a way that it is guided downwards along the funnel wall. If required, in the lower part of the buffer reservoir 16 there may be arranged an extra guide element in order to influence a stationary course of the flow of liquid in a positive manner. To that end there is furthermore provided a circulation line 17 which, at one end, is connected to said buffer reservoir at the upper side thereof or near thereto and, at the other end, debouches into the discharge line of the quantity meter 10, i.e. into the part of the milk line 4 that is connected to the exit of the passage element 11. Because of this the difference in pressure across the quantity meter is mainly limited to the pressure exerted by the quantity of liquid in the buffer reservoir 16. Furthermore, the quantity meter is connected to the buffer reservoir 16 through a certain angle which, in the present embodiment, lies between 20° and 50°. The rate of flow (v) of the liquid through the passage element 11 is determined by correcting a constant value obtained by means of calibration by a factor depending on the quantity of liquid to flow through, which quantity is present in the buffer reservoir 16, and the angle through which the quantity meter, in particular the passage element 11, is connected to the buffer reservoir 16. This correction factor can be obtained, by means of calibration, for various quantities of liquid present in the buffer reservoir and for a determined angle value. By storing said constant value together with the correction factor in the memory of a microprocessor 18 or an other type of computer, the rate of flow (v) of the liquid, required for the determination of the quantity of liquid to flow through, depending on a supposed or, which is better of course, measured liquid level in the buffer reservoir 16, will be known. Of course, the quantity meter will also function when the rate of flow is determined otherwise.

[0014] In Figure 4 the pattern of the electric conductivity G(t) in the time t is shown, i.e. in the situation that the milk yielded via a teat cup from an udder quarter of a cow is supplied pulsationwise to the quantity meter 10. The frequency at which the milk is supplied thereto is determined by means of the pulsation system 8. In this figure the maximum conductivity, ascertained in the intervals of time when the volume a*l is completely filled, is indicated by G_{abs}. The value of G_{abs} varies somewhat in the course of a milking run; moreover, this value is different for each cow. Because, after the milk has passed through the volume a*l, there will always remain a thin film of milk, there is measured almost permanently a conductivity characterized by background noise. When there is really a relevant quantity of milk in the volume a*l, then there is measured a conductivity above a fixed threshold value $\alpha * G_{abs}$; in the present application

α appears to be in the order of 0.3 to 0.4. It is preferable to choose a threshold value depending on G_{abs} instead of a constant threshold value. The difference G_{abs}-α^*G_{abs} can then be standardized at a constant value, e.g. "1", because the quantity measurement must not depend on differences in the electric conductivity of the milk of different animals. By measuring the conductivity, insofar as the latter exceeds the threshold value, at a relatively high frequency, in the computer the surface defined by the function G(t) can be calculated, insofar as the function values exceed the threshold value, which means, because of the applied standardization of the value G_{abs} - α^*G_{abs}, that there can be determined an average value Δt, i.e. the time when a milk pulsation flows through the passage element 11. For such a milk pulsation it applies that the latter represents a quantity of milk $V = a^*v^*\Delta t$. When for each of these liquid pulsations the quantity (V) has been determined, on the basis thereof the total quantity V_{tot} can be calculated by summation.

[0015] The above-described quantity meter 10 can in particular be applied in an implement for automatically milking animals, such as cows, which implement comprises a milking robot 19, controlled by the computer 18, for automatically connecting teat cups to the teats of an animal, respectively disconnecting same therefrom. Especially in such an implement, in the absence of permanent human supervision, it is important to have a reliable quantity meter at one's disposal. The quantity of milk obtained from the separate quarters can continually be updated, so that there is realized at the same time a regular control of the condition of health of the udder.

[0016] The invention is by no means restricted to the embodiment shown, but also relates to all kinds of alternatives, in particular those indicated in the introduction of the description, of course, falling within the scope of the following claims.

Claims

1. A quantity meter for determining the quantity of liquid flowing through a line, said quantity meter comprising two electrically conductive elements, provided in the line at a fixed measuring distance from each other, which are connected to an electronic circuit, whereby the diameter of the line, at least across the measuring distance, is such that during flowing through of the liquid the volume of the line across the measuring distance is completely filled for some time, and whereby furthermore in the electronic circuit the quantity (V) of liquid flowed through is determined on the basis of the electric conductivity (G(t)) of the liquid measured therein, dimensioning parameters of the quantity meter and the rate of flow (v) of the liquid, **characterized in that** each of the electrically conductive elements is constituted by a tube-like element, which tube-like elements are both kept at a fixed mutual distance (1) from each other by means of a further tube-like element made of an electrically non-conductive material and having an internal diameter which equals that of the adjacent parts of the two electrically conductive tube-like elements.

2. A quantity meter as claimed in claim 1, **characterized in that** the electronic circuit comprises a microprocessor, in which the length of the interval of time (Δt), during which a quantity of liquid to be measured has flowed through the line, is at least approximately determined on the basis of the electric conductivity (G(t)), and in which the quantity (V) of liquid flowed through is at least approximately determined by the relation $V = a^*v^*\Delta t$, whereby (a) represents the size of the surface of the cross-section of the line between the electrically conductive elements, and the value of the rate of flow (v) is ascertained by means of calibration.

3. A quantity meter as claimed in claim 2, **characterized in that** in the microprocessor there is determined the absolute conductivity (G_{abs}), ascertained in the time when the space in the line between the measuring points is completely filled with liquid, as well as a threshold value (α^*G_{abs}) depending thereon, whereafter the size of the surface defined by the function (G(t)) defining the electric conductivity is calculated, insofar as the function values exceed the values exceed the threshold value (α^*G_{abs}), whereby the difference (G_{abs} - α^*G_{abs}) between the absolute conductivity (G_{abs}) and the threshold value (α^*G_{abs}) is standardized at a constant value, e.g. "1", said surface defining the value of the interval of time (Δt).

4. A quantity meter as claimed in any one of the preceding claims, **characterized in that** said quantity meter is connected to a buffer reservoir, and there is provided a circulation line which, at one end, is connected to said buffer reservoir at the upper side thereof or near thereto and, at the other end, debouches into the discharge line of the quantity meter.

5. A quantity meter as claimed in claim 4, **characterized in that** the buffer reservoir is funnel-shaped in downward direction.

6. A quantity meter as claimed in claim 4 or 5, **characterized in that** said quantity meter is connected to the buffer reservoir through an angle between 20° and 50°.

7. A quantity meter as claimed in claim 4, 5 or 6, **characterized in that** in the microprocessor the rate of flow of the liquid is determined by adjusting a con-

stant value, obtained by means of calibration, by a factor depending on the quantity of liquid to flow through, which quantity of liquid is present in the buffer reservoir, and the angle through which the quantity meter is connected to the buffer reservoir, which factor is obtained, by means of calibration, for a number of quantity values in the buffer reservoir and for a determined angle value.

8. A quantity meter as claimed in any one of the preceding claims, **characterized in that** the line comprises a narrowing, and the electrically conductive elements are disposed in this narrowing.

9. A quantity meter as claimed in any one of the preceding claims, **characterized in that,** when the flow of liquid flows pulsationwise through the line, in the microprocessor the quantity (V) of each of these pulsations is determined and on the basis thereof, by summation, the total quantity (V_{tot}).

10. An implement for milking animals, such as cows, which implement comprises a quantity meter as claimed in any one of the preceding claims.

11. An implement as claimed in claim 10, **characterized in that** said implement comprises teat cups capable of being connected to the teats of animals to be milked and a milk tank for collecting the milk obtained via the teat cups, whereby in a line between one or more teat cups and the milk tank there is included a buffer reservoir to which the quantity meter as claimed in any one of claims 1 to 10 is connected, while there is furthermore provided a circulation line which, at one end, is connected to said buffer reservoir at the upper side thereof or near thereto and, at the other end, debouches into the discharge line of the quantity meter.

12. An implement as claimed in claim 10 or 11, **characterized in that** there is provided a milking robot for automatically cleaning the teats, automatically connecting the teat cups to these teats, automatically milking the animal and automatically disconnecting the teat cups from the teats.

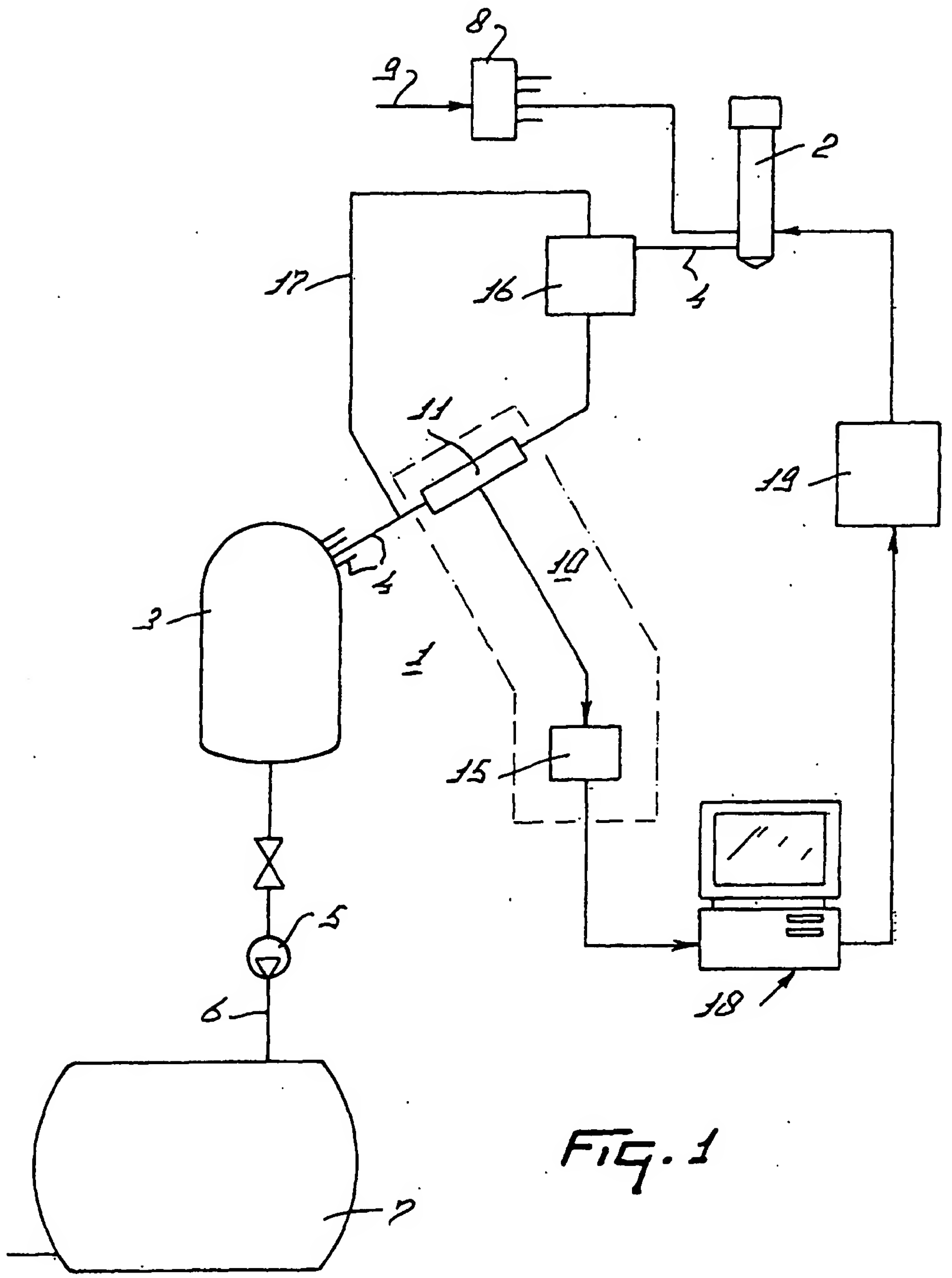


FIG. 1

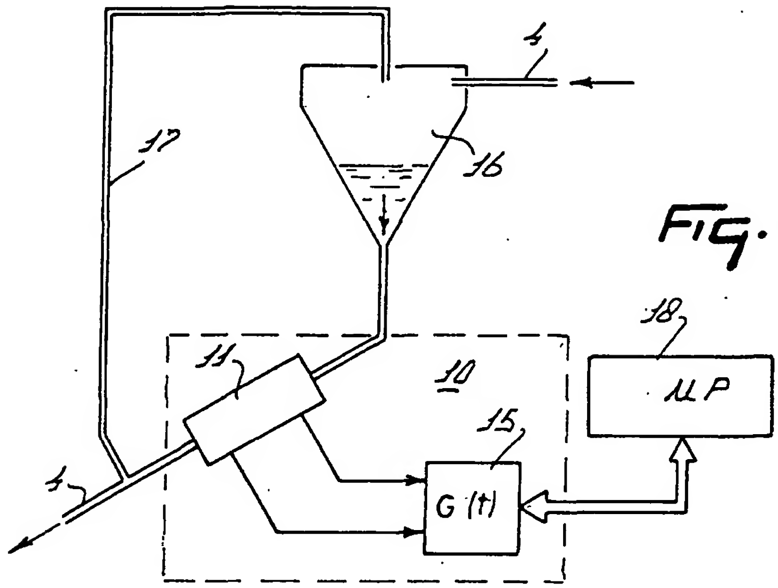
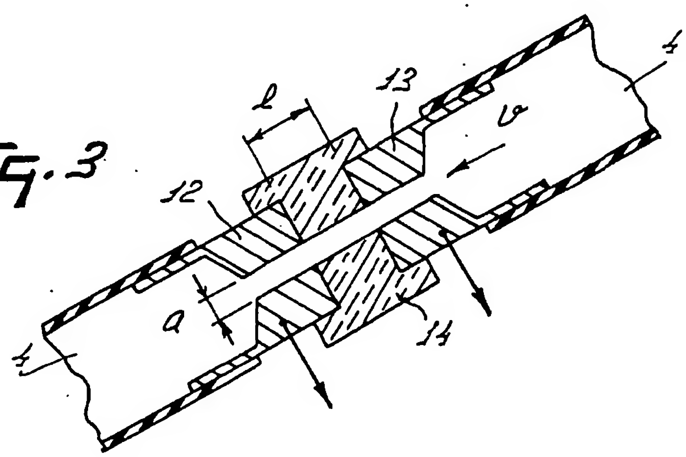


FIG. 2

FIG. 3



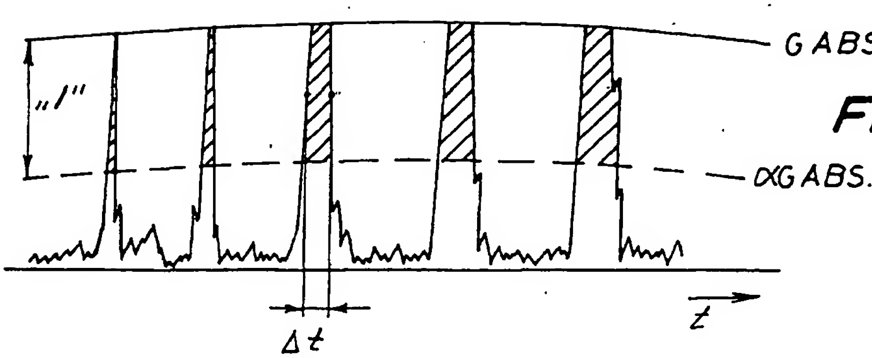


FIG. 4